Multimodal Neuroelectric Interface Development

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Overview

What's New About this Research

— Interfaces for mobile or restricted environments

— Augmented interaction in normal environments

Research Interests

— EMG- and EEG-based control

— Multimodal control

— Real-time algorithms

— Signal processing framework

— Contactless sensors

Aircraft Simulation

Demonstration: Eight channels of EMG are recognized as flight stick motions

F-15 Simulation
757 Transport Simulation

Typing Demonstration

Demonstration: Eight channels of EMG are recognized as keystrokes when pretending to type on a keyboard number pad.
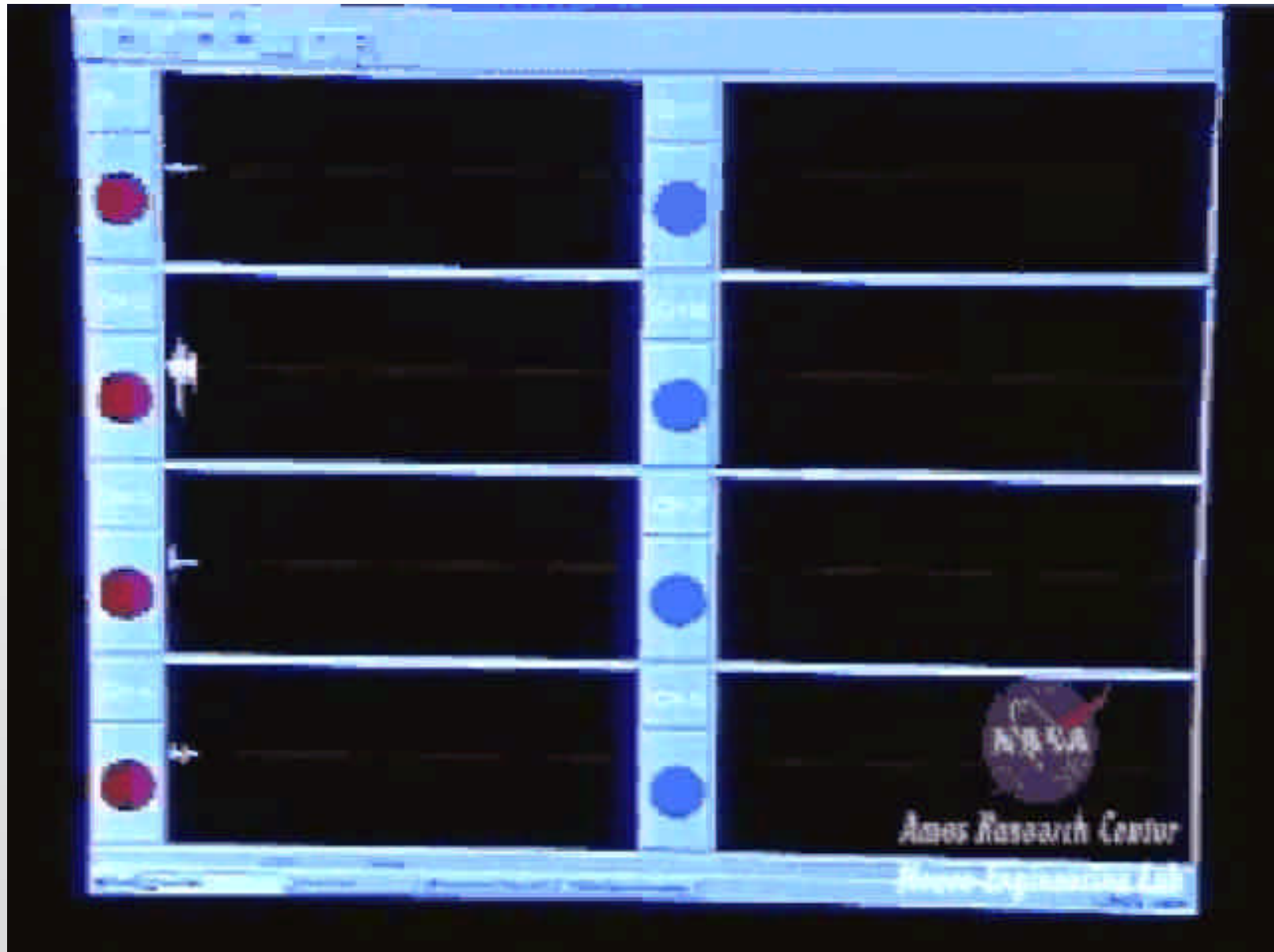
Purpose
- Replace physical keyboard
- Keep hands free of gloves or other apparatus

Issues
- Typing style is critical
- Adjust sensors and algorithms to individual
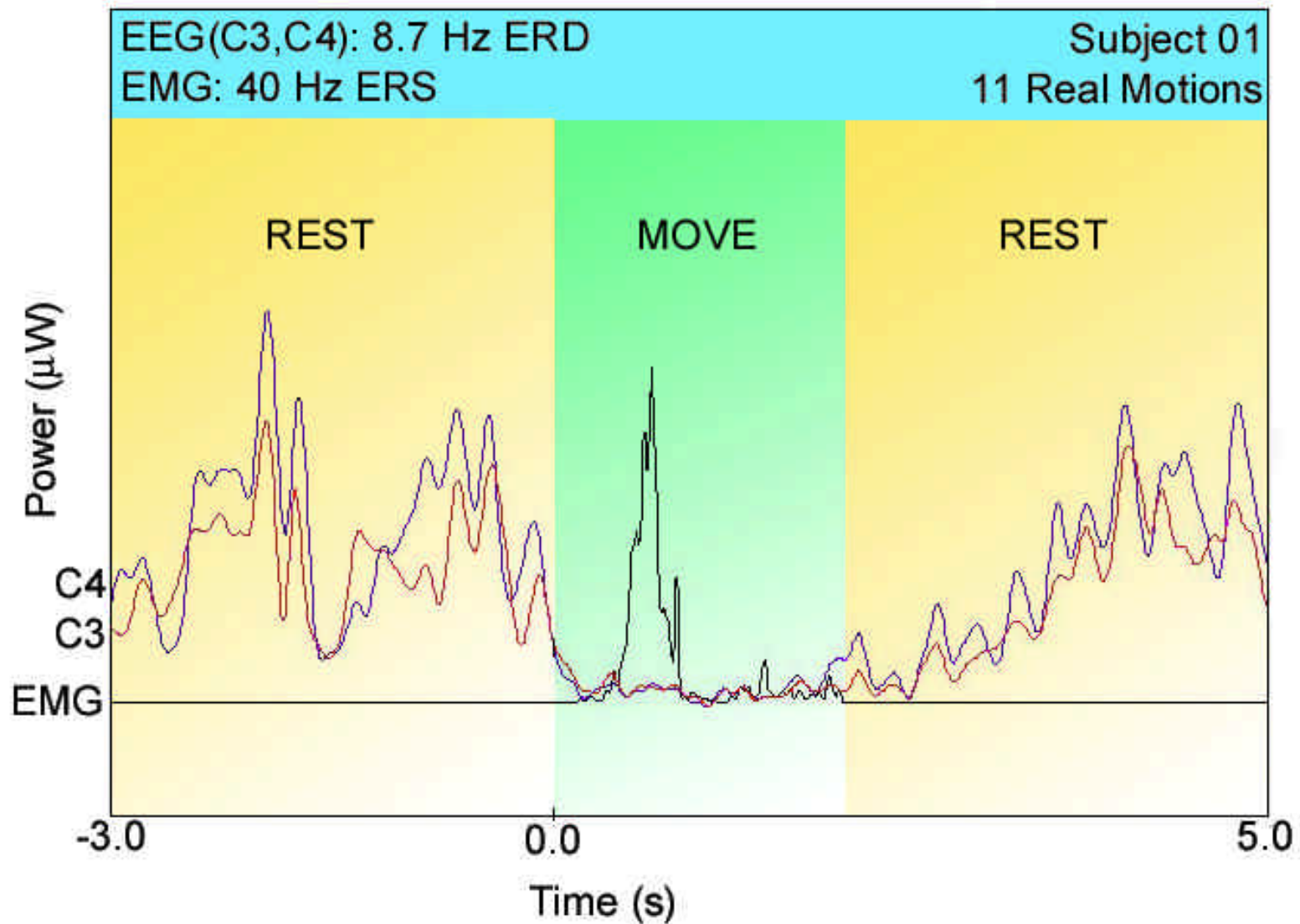- Unobtrusive sensors

EMG Control Demo
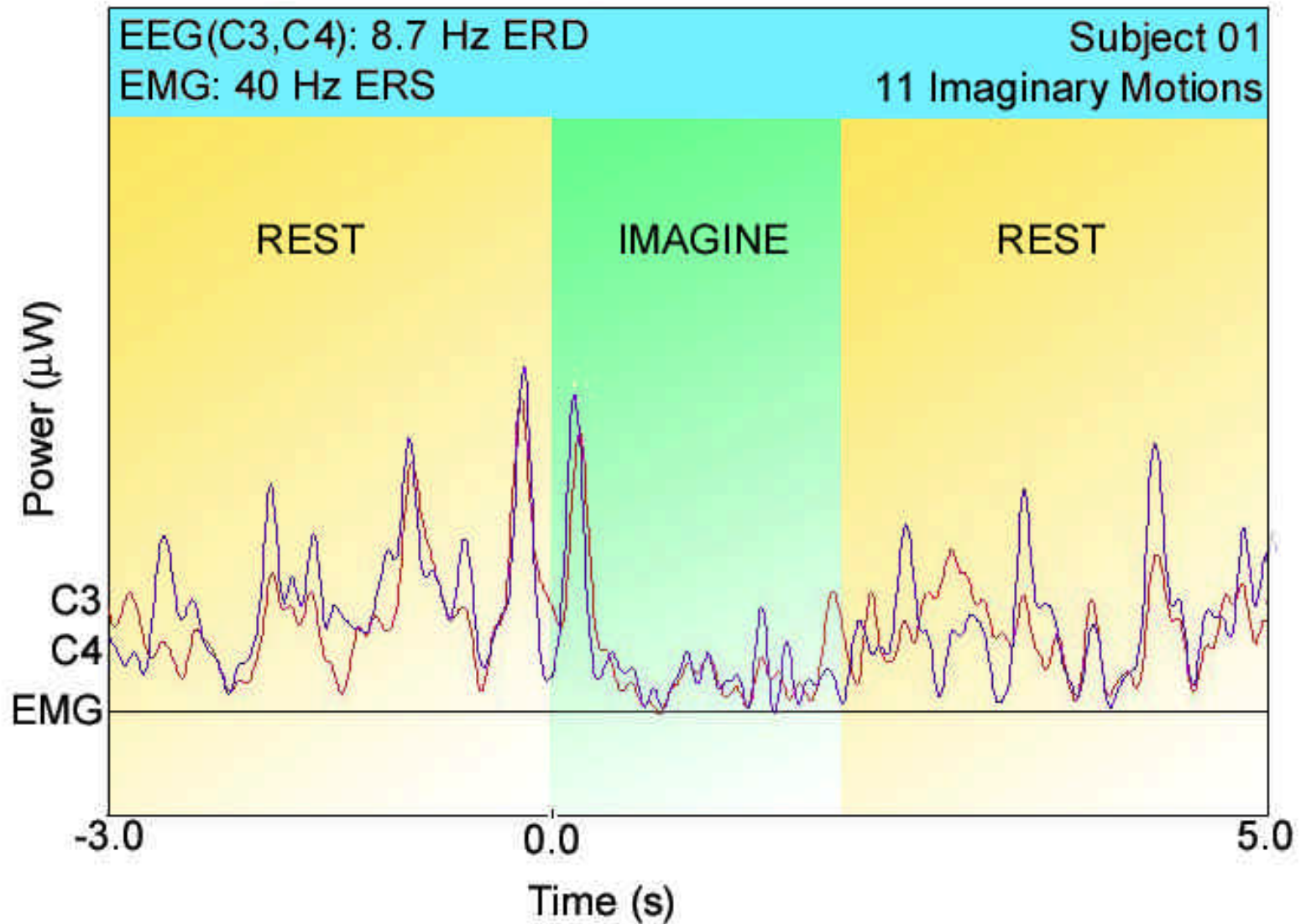
Reaching Task - Eleven Motion Epochs
8.7 Hz ERD at C3 & C4 from -3 to +5 sec relative to onset of motion
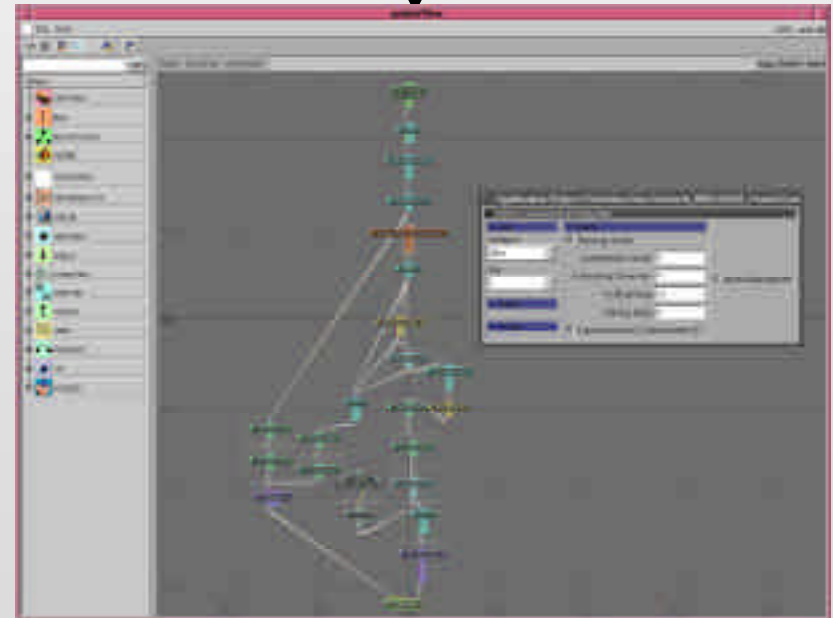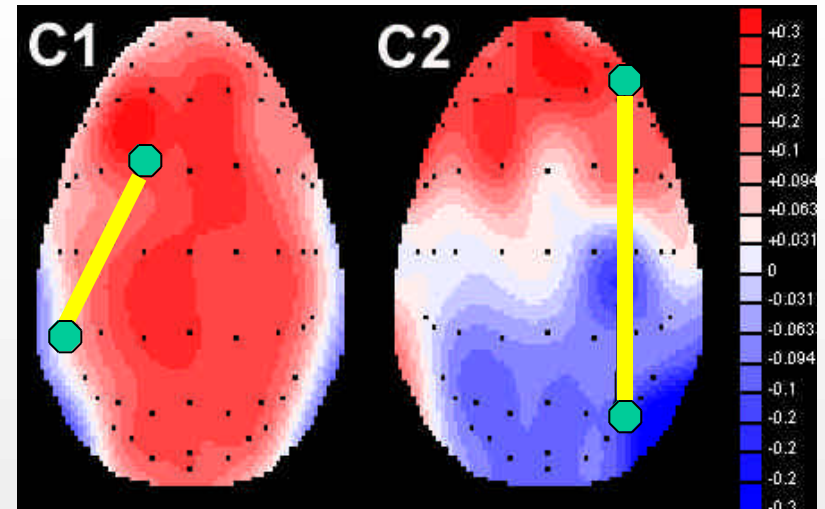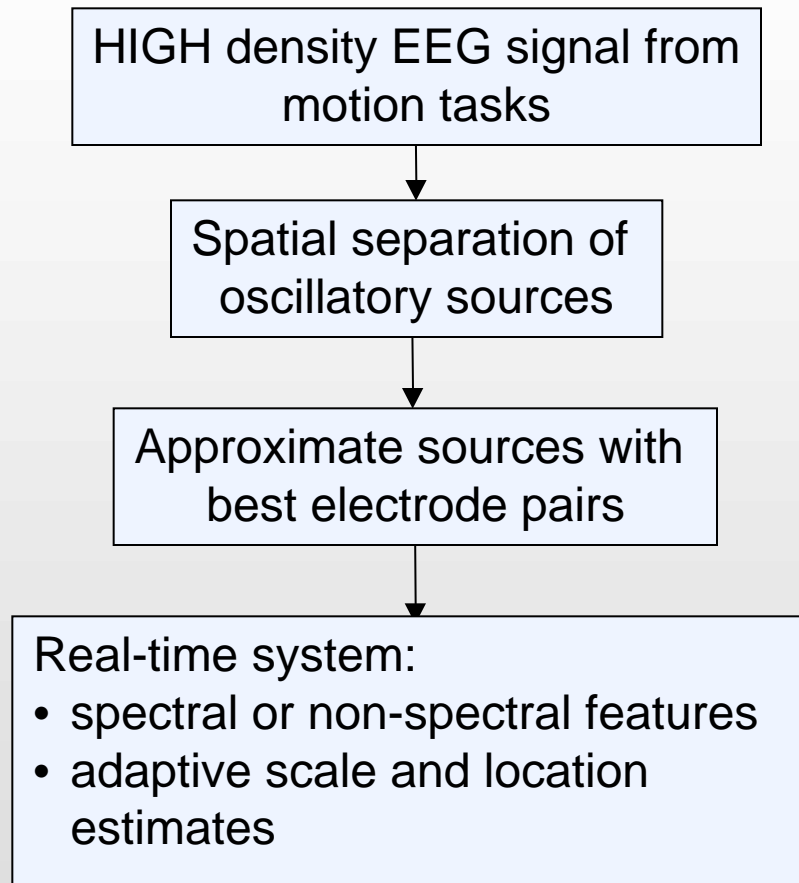
Imaginary Reaching Task - Eleven Motion Epochs
8.7 Hz ERD at C3 & C4 from -3 to +5 sec relative to onset of motion

Closed-loop 1-D Control Experiments
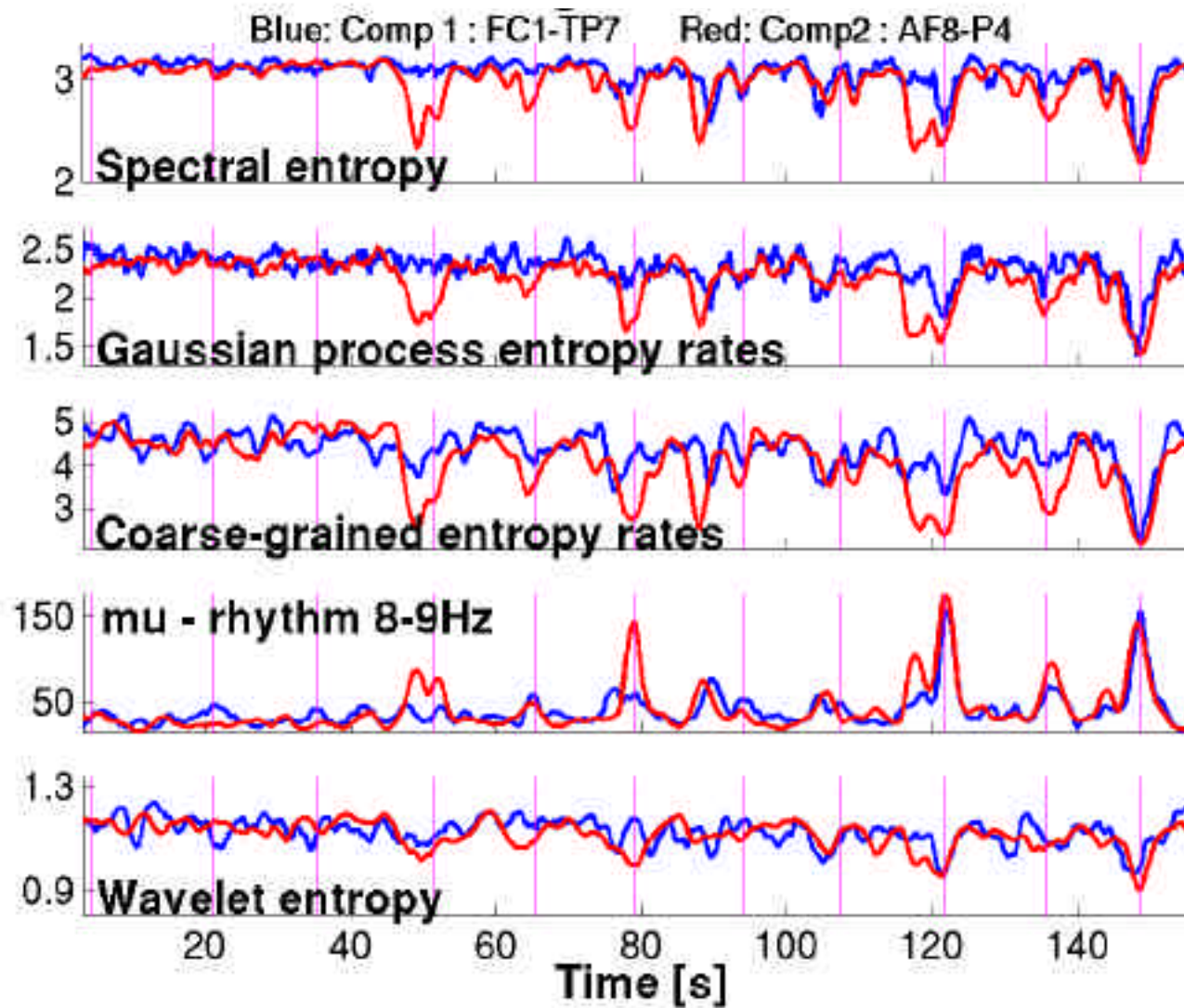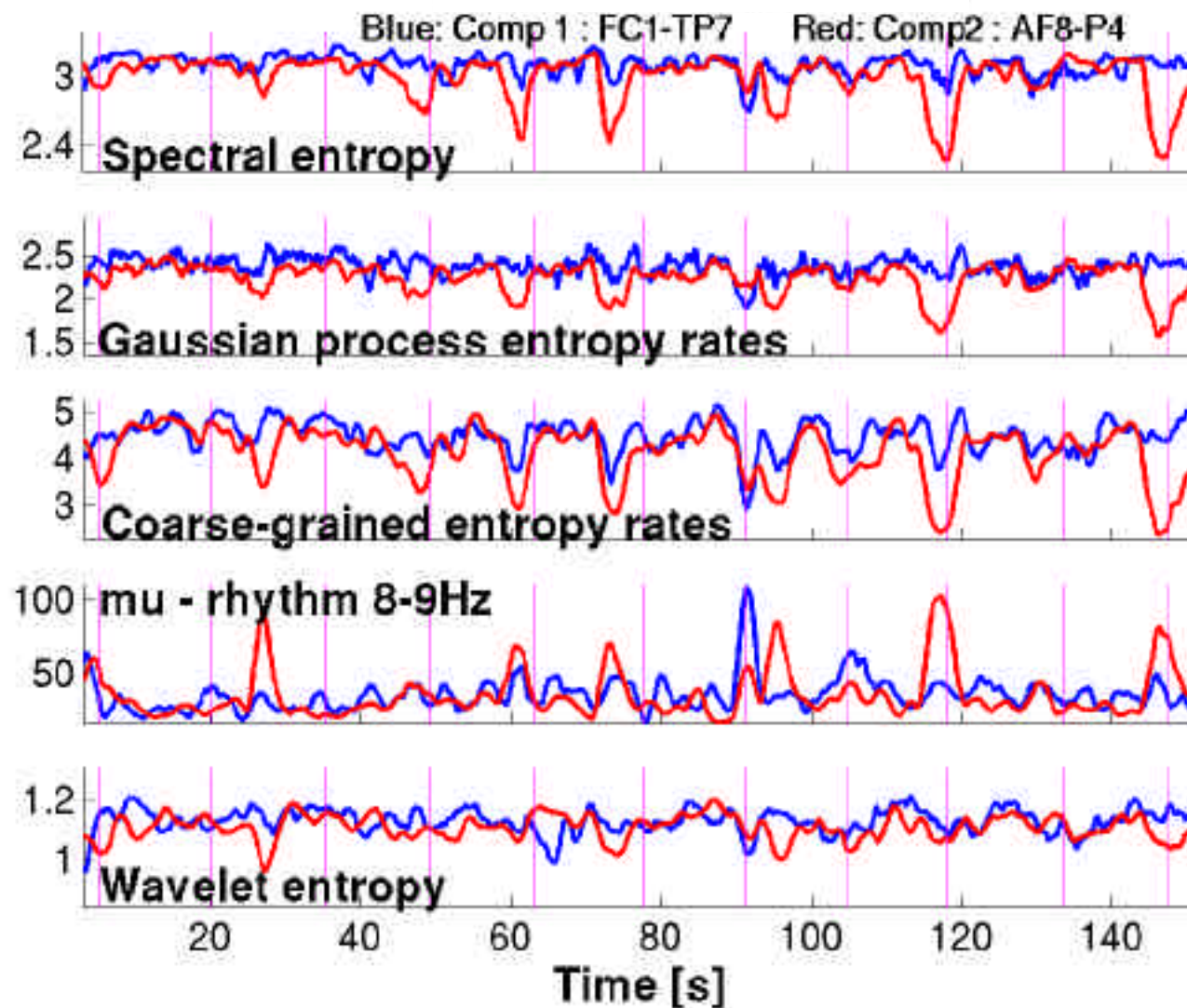
HIGH density EEG signal from motion tasks

Spatial separation of oscillatory sources

Approximate sources with best electrode pairs

Real-time system:
- spectral or non-spectral features
- adaptive scale and location estimates

Real Right-hand Motion

Blue: Comp 1 : FC1-TP7   Red: Comp2 : AF8-P4

Spectral entropy

Gaussian process entropy rates

Coarse-grained entropy rates

mu - rhythm 8-9Hz

Wavelet entropy

Time [s]

Imaginary Left-hand Motion
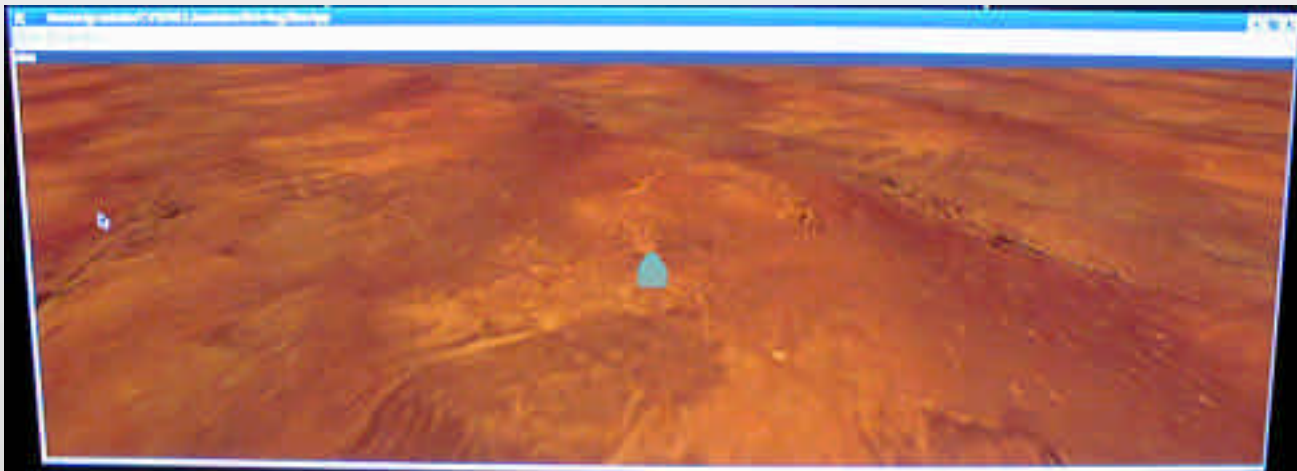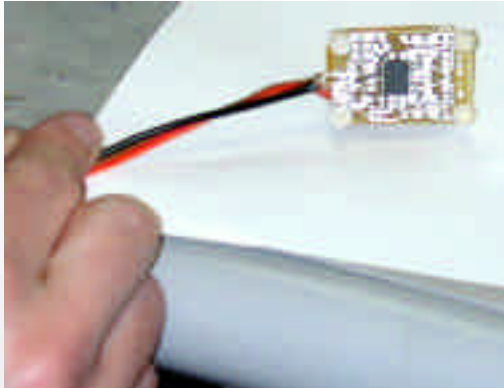
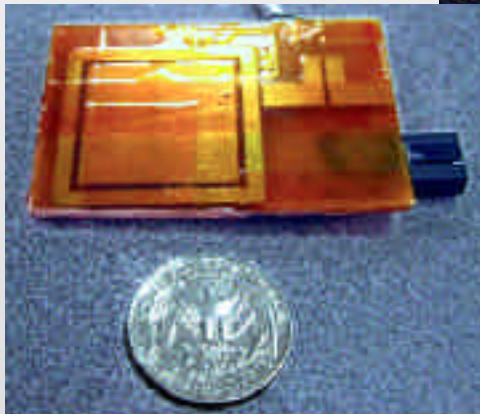# Closed Loop Training Task

Closed Loop Moving Map Control

Non-contact Sensor Development

QUASAR Stacked Sensor

Eight-channel EEG plus EOG and QUASAR Sensor Recordings

Lash-up of Mini-differential
Quasar Sensor

Design Goals

Near-term
- Refine non-contact technology
- E-field sensor (normal to scalp)
- Shielded room

Mid-term
- Differential sensor (tangential to scalp)
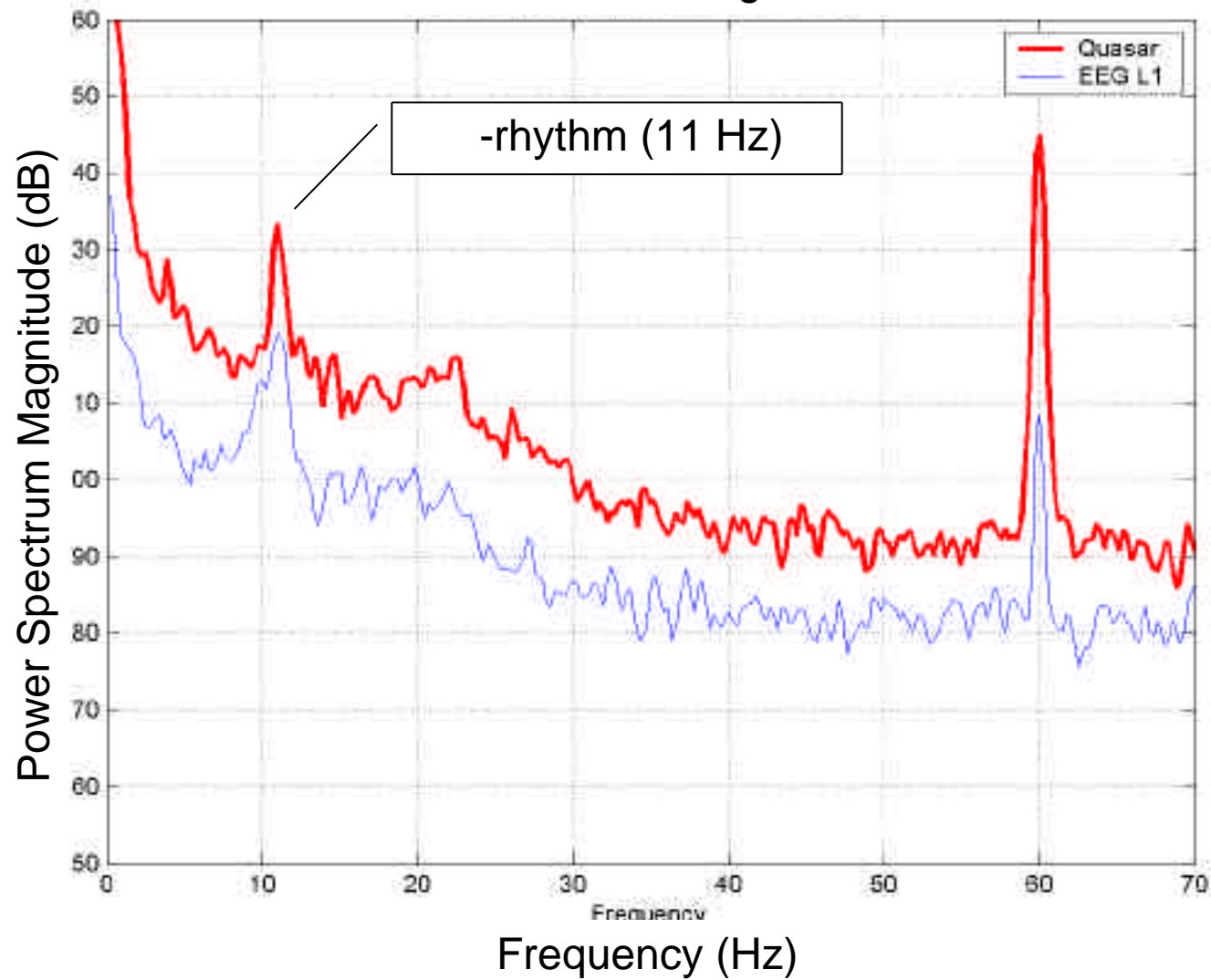- Mini sensors (2-3X smaller, thinner, with manufactured cover)

Long-term
- Unshielded room
- Multichannel

QUASAR: Quantum Applied Science and Research Inc.

Capacitive Sensor Data

Visual Monitoring Task

Future Directions

— Multimodal neuroelectric control with concurrent motion

— Communication and control using event-related cortical potentials (attention, intention)

— Wireless/contactless technology for neuroelectric control

— Validate contactless sensors with ECoG or intracranial recordings